

Vision

To enhance the nation's security and prosperity through sustainable, transformative approaches to our most challenging energy and climate problems.

Solar Energy Programs

The Energy Security program area accelerates the development of transformative energy solutions that will enhance the nation's security and economic prosperity.

Sandia National Laboratories conducts research and development (R&D) in solar power, including photovoltaics and concentrating solar power, to strengthen the U.S. solar industry and improve the manufacturability, reliability, and cost competitiveness of solar energy technologies and systems. Researchers at Sandia partner with the U.S. Department of Energy (DOE) and other government agencies, industry, academia, and other laboratories to accelerate development and acceptance of current and emerging solar power technologies.

Concentrating Solar Power R&D

The Concentrating Solar Power (CSP) program at Sandia National Laboratories conducts research to reduce costs and identify opportunities for improvement of CSP technologies, advance understanding of CSP system behavior, increase efficiency and capacity for baseload CSP applications, and reduce risk for CSP technologies and increased levels of concentrating solar power in the transmission grid. The program also develops advanced modeling and validation techniques that integrate structural, optical, and thermal processes for better predictive and analytical capabilities.

Sandia's research spans the range of CSP system architecture with R&D activities in line-focus/trough, dish/engine, and power tower technologies. The lab also conducts research in thermal storage components and systems. Through comprehensive industry and university partnerships, Sandia's CSP team performs extensive parametric analysis aimed at improving system performance, enhancing structural design, and optimizing cost and performance models. CSP experts at Sandia lead activities in glint and glare analysis, heliostat modeling, particle receiver modeling, coupled processes and integrated models, thermal storage

processes, reflectivity and solar radiation modeling, and on-sun testing of multiple technologies. The lab offers proficiency in probabilistic and stochastic modeling, which can be used evaluate a wide variety of CSP system scenarios and factors. The CSP program also engages in Sunshine to Petrol research.

Photovoltaic Systems Research & Development

Sandia's photovoltaic (PV) program conducts research to improve the performance, reliability, and cost effectiveness of PV components and systems through testing and characterization, modeling and analysis, and systems engineering. This work spans the range of cell and device R&D; laboratory-based component and system evaluation, characterization and optimization of fully fielded PV systems, accelerated lifetime testing, inverter and power electronics development and characterization, on-site weather and irradiance data analysis; and removal of technical and nontechnical barriers through codes and standards, new technology development, and assistance to project-implementing partners. The PV systems reliability program uses Sandia's extensive expertise in materials, manufacturing, statistical analysis, and system-level accelerated testing. Researchers at the lab are developing novel approaches to fabricating ultra-thin PV cells that reduce semiconductor materials in modules, and Sandia's optics expertise is being applied to develop low-cost micro-concentrators for PV modules.



Researcher Geoff Klise worked with Solar Power Electric to develop a tool that can be used to appraise photovoltaic installations on homes and businesses.

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Solar Codes & Standards

Standards, codes, and certifications are critical to enabling the growth of solar power. Sandia uses its technical expertise and comprehensive research portfolio to provide informed technical guidance for developing and improving codes and standards and the processes by which they are verified. Sandia's solar researchers perform testing, analysis, and validations that provide unbiased evaluations of current and proposed standards.

Sandia's solar staff participates in developing and validating codes and standards with organizations such as the American Society of Mechanical Engineers, the National Electrical Code®, Underwriters Laboratories, the International Electrotechnical Commission, and IEEE. Working with these and other partner organizations, Sandia supports the development of domestic and international standards that reduce market barriers to greater adoption of solar technologies while simultaneously assuring improved safety for operators and installers as well as reliability and functionality of installed systems.

Grid Integration Research & Development

The Grid Integration Program at Sandia National Laboratories addresses technical barriers that hinder large-scale deployment of renewable energy generation in grid-tied power systems.

Activities of the Grid Integration Program include:

- operating prototyped PV systems and analyzing resulting data, including short-term PV variability;
- developing PV system models for grid planning and interconnection studies, including regional models that link weather, electric demand, and widely distributed, high-penetration solar power;
- researching advanced power electronics and controllers for scalable microgrids and other high-

penetration scenarios, including new anti-islanding algorithms; and

- developing tools to assess effects of high levels of PV and CSP penetration on transmission and distribution systems.

Sandia also manages DOE's Solar Energy Grid Integration Systems (SEGIS) program. SEGIS is a public/private industry-led partnership focused on next generation PV-related inverters, controllers and energy management systems.

Solar Research User Facilities at Sandia

Operated by Sandia for DOE, the **National Solar Thermal Test Facility (NSTTF)** is the only test facility of its type in the United States. NSTTF provides design, construction, and operation of unique components and systems in proposed solar thermal electrical plants for large-scale power generation. The facility includes an eight-acre heliostat field, a five MW_{th} power tower, and a molten-salt test loop. NSTTF also provides high-heat flux and temperatures for materials testing and aerodynamic heating simulation, large fields of optics for astronomical observations or satellite calibrations, a solar furnace, and a rotating platform for parabolic trough evaluation. In 2010, the facility initiated upgrades to further enhance CSP R&D including an expanded molten salt test facility, a new optical test laboratory, and a trough alternate working fluids test facility.

Sandia's **Distributed Energy Technologies Laboratory (DETL)** uses a reconfigurable infrastructure comprised of distributed generation sources, storage, and programmable loads to simulate electric grid and microgrid scenarios such as island and campus grids, remote operations,

and scaled portions of utility feeders and transmission infrastructure. DETL engineers are skilled in high-penetration renewable integration, component and system performance testing, modeling, cyber-security integration, microgrid communications, enhanced efficiency, and load control.

The **Photovoltaic Systems Evaluation Laboratory (PSEL)** is a multi-user, multi-sponsor facility that conducts research in PV cells and modules and performs detailed analyses to support PV systems design and optimization. In addition to reliability and availability testing, PSEL capabilities include irradiance calibrations, spectral characterizations, and reference cell measurements.

Other research sites at Sandia contribute to the lab's solar research through the advancement of innovative materials and processes. Sites include:

- Center for Integrated Nanotechnologies
- Microsystems and Engineering Sciences Application Complex
- Microelectronics Development Lab
- Advanced Manufacturing Processes Laboratory

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